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Bibliographies and Literature of Agriculture No. 10

Rooting Habits of Selected Commercial Tree Species of the Eastern United States—A Bibliography

Rooting Habits of Selected Commercial Tree Species of the Eastern United States— A Bibliography

Compiled by
Penninah Smith and Leanne Every

Formerly, on Intergovernmental Personnel Act assignment to the Eastern Region, from the University of Illinois; and research technician, Northeastern Forest Experiment Station, respectively.

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Introduction

A great variety of research has been conducted to study the rooting habits of trees. However, little of this literature has been synthesized to describe the rooting habits of particular tree species or groups of species in ways that would be useful to field foresters. The objective of this bibliography is to facilitate review of literature pertaining to rooting habits of commercially important tree species occurring in the Eastern United States, especially those that occur in the Northeast (Region 9, Forest Service, U.S. Department of Agriculture).

We have attempted to be thorough, but the result is not complete. This list focuses on the years after 1930. The literature on the genus *Pinus* has been searched more thoroughly than the other genera. Aspects of disease and mycorrhizae that do not pertain directly to root character are not emphasized. Horticultural species, for the most part, have been excluded. References to commonly planted exotic species, such as *Pinus sylvestris* L., have been included, especially when the research was conducted in the Eastern United States or the species was judged to have commercial importance there.

The entries are primarily from Biological Abstracts, Forestry Abstracts, and references cited in articles. If a paper has been abstracted in Biological or Forestry Abstracts, the abstract volume and article number are given with "FA" or "BA" at the end of the entry.

The titles of journals and publishing agencies are abbreviated according to the International List of Periodical Title Word Abbreviations (ISO 833–1974 E) of the International Organization for Standardization, with certain exceptions (e.g. the use of USDA for U.S. Dep. Agric.). Journal titles thus appear approximately as they are shown in the annual BIOSIS List of Serials (BioSciences Information Services, Philadelphia), where the full titles, CODEN symbols, countries of origin, and information about mergers, changes of title, and the like may be found.

The bibliography is arranged alphabetically by the author, and the entries are numbered consecutively. A subject index is given in the appendix. To find articles on root grafting of white pine, for example, first find the symbol for root grafting (IIIA–2) in the key to the subject index. Then turn to *Pinus strobus* in the species column of the subject index and find IIIA–2 in the subject columns. The 12 numbers listed under IIIA–2 refer to entries in the bibliography that concern white pine root grafting.

The subjects covered in the bibliography are outlined in the following list, which is the basis for the key to the subject index.

I. Root growth and development
   A. Form and anatomy
   B. Relation to top growth and development
   C. Genetic variation, within species
   D. Periodic, seasonal
   E. Influenced by:
      1. Root environment
         a. Moisture
            i. Drought
            ii. Flood
         b. Temperature
         c. Soil
            i. Physical aspects
            ii. Chemical aspects
            iii. Microrelief
      2. Shoot
         a. Light
         b. Hormones

II. Root functions
   A. Uptake and upward translocation
      1. Water
      2. Nutrients
      3. Other substances
   B. Translocation downward
      1. Carbohydrate reservation
      2. Exudation
   C. Respiration
   D. Anchorage

III. Root interactions, biological
   A. With herbaceous and woody plants
      1. Spatial relations (competition for nutrients and moisture)
      2. (Natural) root grafting
      3. Soil amelioration
         a. Exudation
         b. Root death
      4. Allelopathy
   B. With other than herbaceous and woody plants
      1. Symbiotic relations
         a. Mycorrhizae
            i. Ecto-
            ii. Endo-
            iii. Eclendo-
         b. Nitrogen fixation
            i. Leguminous
            ii. Non-leguminous
      2. Pathological relationships
         a. With undetermined or mechanical agent
         b. With determined agent
            i. Insect
            ii. Nematode
            iii. Fungus
            iv. Bacterium

IV. Root response to nursery and forestry practices

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Appendix

Key

	Subject
IA,B	Root form and relation to vegetative growth
IC	Genetic variation in root growth and development
ID	Periodic and seasonal aspects of root growth and development
IE–1	Influences of moisture, temperature, and soil on root growth and development
IE–1a	Influence of moisture extremes on root growth and development
IE–2	Influence of the shoot on root growth and development
IIA	Uptake and upward translocation
IIB–1	Translocation downward—carbohydrate reservation
IIB–2	Translocation downward—exudation
IIC	Root respiration
IIIA–1	Competition with woody and herbaceous plants
IIIA–2	Root grafting
IIIA–3	Effects of roots on soil
IIIB–1	Symbiotic relations with other than woody and herbaceous plants
IIIB–2a	Diseases of mechanical or undetermined cause
IIIB–2bi	Insect disease
IIIB–2bii	Nematode disease
IIIB–2biii	Fungus disease
IIIB–2biv	Bacteria disease
IV	Root response to nursery and forestry practices

See page iii of the introduction for instructions on the use of the key and the subject index.

Subject Index

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Abies spp.						253					150			554 1181						
Abies balsamea	859 559 67 382 68 71 1052 1343 86 978		68	349 12 859 559 1052		747 740 746 253 939 71	978 20 338	740			690 446 659 658	86 978		859 783 1181	1123 788 871 923 1126	1244 1245 1121 1096 708	792	1122 1269 1272 310 1096 32 579 480 1087 1116 695 1085 696		11
Acer spp.	830					1210	852				150		601	94 1181 631 324	1318 1209 1141	448	792	207		1209 1210
Acer negundo	128 1332 830 211 465 509 935 238			1332 128 481 566 568 174 104 755		128 935 15	568				128 446 15 238			809	871		792	996		
Acer nigrum	830																			
Acer pennsylvanicum	830		72																	
Acer rubrum	856 781 763 1178 349 1310 1313 762 830 1130 826 934 828 827 829 114 1200 1309 1343 1308 1135 336 382	828 856	226 72 1326 891 892 890 763 1313	763 762 1311 828 114 1309 336 727 349 1115 566 12 1226 778 482 481 164 1178		1226 762 605 763		913 1326	115 724	762 1135 446 658 659			762 826 829 114 779 278 1222 155	292 871 1310 1313 1210			207		934 963

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Acer saccharinum	1332		1256	983		1333	568			1177	238			779				32		1256
	830		780	174		423					446									
	983		982	104		988					710									
	989		988	1177		989					15									
	238		1254	568		743														
	781			566		747														
				1333		1254														
				481																
				455																
				1332																
				15																
Acer saccharum	908		867	372		372	713	909	1102		372		1184	372	372	209		1240		416
	372		1256	872		371	226	910	1101		1135		1185	867	871	1239		1237		608
	128		462	128		416	72	1243	1103		13			859	131			1239		1241
	1186		437	859		909	467	912			446			637	1210					1246
	1184		1161	174		743	891	1241			690			1181	1209					334
	830		333	909		747	892	1238			658			155	839					
	1101		334	908		1255	890	334			659			779						
	375			372		334		911												
	1135			872																
	382			867																
	1056			481																
	13			1161																
	211			1254																
	559																			
	934																			
	859																			
	781																			
	608																			
Aesculus spp.	547																			
Aesculus glabra	781			128		128														
	128																			
Aesculus octandra					481															
					174															
Alnus spp.	106			135			1300							631						
														135						
														137						
														1181						
														106						
														138						
														139						
Alnus glutinosa	791		999	791	52	791	521	1265			790			777	791					1232
	117		462	790	790	427								790						
				117	427									791						
				777	777									141						
				999										144						
				144										1232						
				140										1265						
														141						
														96						
														142						
														139						
														1181						
														997						

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Alnus glutinosa (con't)														931 858 521 332 136						
Alnus rugosa					778 481 482									997 1219 858 281 139	871					
Alnus serrulata					174									139 631 997						
Asimina triloba	781				482															
Betula spp.	755			698 1300			698 1300 338 890				755	150		1181 807	871 1210 839	448		207		
Betula alleghaniensis	372 1178 934 1107 957 1186 762 486 1184 559 382 859 608	1022	372 956 957 486 559 954 1176 1183 575 576 577	372	372	372 743 747	576 577 1022 72		1103		762	372 710 658 659 446	1184	372 953 956 859 33 622	372 1107 889 503 209 456 953 955 956 957 958 237			1269 1203 310		934 1176 608
Betula lenta	1135			116			226 72				1135 446			1181 1049 807 810	116					
Betula nigra		163 328	163	481 455 1333 778 482 174	328				163 724		446			1181 810						
Betula papyrifera	1107 1313 562 561 946 934 1343 752 1200	1313	956 937 752 585 516 1268	12	743 747 562					86	561 690 658 659 446			956 779 1181	1107 209 956 958 237 1276 1313 410	448	1347	272 900		934 796 1268

Species	Subject																				
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Betula populifolia	1178 762			1049			892 891				762			1049 807 810	1049 410 614		792			
Carpinus caroliniana	781				481 482	605	72							1181				1269		
Carya spp.	134 394 1178 413 182 184			1178 182		134 733 605					184	150		1181 94	839 1210					
Carya cordiformis	781 1178			1178		134 373	226 72													
Carya glabra	1192 547 1135			1192	482		72	462				1135 446								
Carya illinoensis	1178 1320 1321		1320 1321	1320 1321		1097 1320		1098 1097				753		1320 1322 1321 1181 810			1320 514	514		1320 1321 1000
Carya lacinosa			780											780 1181						
Carya ovata	781 544 128 211 375			544 128	481 482 174 104	128 134	72							779						
Carya tomentosa	547				481 174 104															
Castanea spp.	547													631				207		
Castanea dentata	1178			1178			72							1181				453 272 1356 207		
Catalpa spp.	509 610				509															171
Catalpa speciosa	465					416														416
Celtis spp.	547 509				482							753								
Celtis laevigata					481 1333 568 566 174															

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Celtis occidentalis	781 1332 465 321			1332	455 565 568 566 174 104		568							321			767	32		171
Cercis canadensis	781 782				481 174 104									782	871 131			1356		
CONIFER	382 68 401 608 375 374		439 462 991	90 301 401 375 991	263	374 991	1130	462						324 521 94	1209 839 521 375 374 1126	708		231 158 718 1162 101 1089 914 537 866 18 404		839 608
Cornus spp.						190	666						601	631		448	792 1347			190
Cornus florida	546 1178 660 184			1335 502	481 906 482 1335 174		72 906							155	906		603	89		502
Cornus stolonifera				786	455		786								871					
Corylus spp.	228			228		228 190								1181						190
Crataegus spp.					481 1333 482 174 104									1181	871		792			
Diospyros virginiana	1049				481 1333 482 174 104										1049					
Elaeagnus spp.														137 138						
Elaeagnus angustifolia	509 1332			755 1332							755			997 139	857 871		797			171
Fagus spp.	524 490			524 1249 490			491 492 339			650 150				324 490 491 492 221	839					650

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Fagus spp. (con't)														94 339						
Fagus grandifolia	859 934 164 559 382 484 1135			859 1135	164 481 482 174	747 934 164 484 1019	226 72 467		1103			484 1135 446		859 1181 1222 545	757 1209 484 871	448		272 207		934 1019
Fraxinus spp.	195			195	482		851				195	150		324 631 1181 94		606				
Fraxinus americana	781 741 382 417 13 1135 908 608		741 1254 1256	755 417 1135 908 236	481 1333 1177 174	1333 747	226 72				13	1135 446		1181 809						796 608 1268 1254 1257 1256
Fraxinus nigra	382				12							710 446								
Fraxinus pennsylvanica	394 238 509 1332 465 321			509 1332 841	455 1226 306 565 769 566 568 569 315 558 553 174 552 104	1226 306 795 605 558	703 568 569		963		238 15 703	650	1323 963	748 321 809	857 871 131		797	1175		171 795 650 963
Gleditsia triacanthos	238 509 465 781 782 1252 195 321 211			128 195 15 841	482 1335 174 104	128 1138 605	131			1335	238 195 15			782 321	857 1335 871 318		797			
Gymnocladus dioicus	781 782													782						
Hamamelis virginiana	548						72									448	792			
HARDWOOD	460 201		439 462	460 375	263	991	91 92	462 1241							839 1209	91		615 718		1209 1241

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
HARDWOOD (con't)	382 375 646		991	646 1021 991				911							1126			101 914		
Ilex opaca				502	482	416 605								1222			792			416 502
Juglans spp.														631 1181						
Juglans cinerea	781 1332 465			1332									611 824 458 1323				792			
Juglans nigra	781 547 394 1178 128 1332 465 15 413 211 235 924 1304			544 128 1332 90 15 235 1304	481 174 104	128 1268	1288	462			924	753	824 291 925 90 458 1051 175 1323 25 1287 410	40	857 871 319		792	272 454 256		235 1304 1268
Juniperus spp.	610													1181			792 1347	996		
Juniperus virginiana	1178 509 1332 195 336 71 44 184			1178 1332 195 336 43	481 906 482 174	71 44	906 1213	462			195				906 857 871 923			1007 435 932 933 681 685 574 538			
Kalmia latifolia	711 726				711									155			792	259		
Larix spp.	401 978			401			1300 978				724	978	252 150	390	631 1181 94	871	1245 1154		251 996	
Larix laricina	946 349 67 382 68 71 297 99 744			946 90 68 297 99 1176 1340	1191 349 730 311	744 747 253 730 421 71 99 311	338						730 710 446		779 1181	68	1244 708	1147 1148 1144	293 1198	1176
Liquidambar styraciflua	244 336			244 336	164 481	558 1226	6 568	926					150 1199		1222 735	1210 521		792	1356 1007	795 1199

Species	Subject																				
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Liquidambar styraciflua (con't)	6			1259	1226	795	870					384		187				1175		
	178			555	482	178	521					446		479				207		
	651				769	651	735							809				996		
					566	555								186				258		
					568	605														
					551															
					557															
					558															
					174															
					553															
					552															
Liriodendron tulipifera	394		669	244	481	268	664	434		1115			601	631	1209	606	792	594		796
	1178		163	872	667		851	268		163			567	324	634			633		734
	244		558	1335	482		226			267			268	155	871			681		1266
	6		267	236	768		6			268				1222	131			685		1257
	734		268	567	769		72			269				642				256		
	669		269	742	1335		870			724								54		
	1114			163	1115		892													
				268	558		890													
					174		1266													
					553		891													
					552		669													
							1288													
Maclura pomifera	509			174	481						195									171
	195				174															
Magnolia spp.							1300													
Magnolia acuminata							266													
Morus spp.															871					171
Morus alba	781			195							195									
	509																			
	195																			
Morus rubra					481	605	1300													
					174															
Nyssa aquatica					482	558	568													
					566		314													
					568															
					558															
					556															
					314															
					174															
					553															
					552															
Nyssa sylvatica	546			727	482	557	557	569												
	727				569	558	558													
					315	174														
					551	552														
					556															
					554															
					557															
					558															

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Nyssa sylvatica (con't)					174 552															
Ostraya virginiana					482		226 72							748						
Picea spp.	1178 524 559 437			524 212 90 437 815		253 212	1300				429	150		922 1181 815	108	1245 708	792 1347 1145	729 192		429 108
Picea abies	999 375 349 649 755 700 509 417 619 930 1083 401 117 543 1023 978 592	627	999 462 700 543	999 450 700 90 417 301 619 301 401 627 117 799	349 700 731 558 53	558 53 755 700 939 1150	512 1 1302 712 978 1086 799 483 724	462 700		627	1 755 619 978	446	700	512 450 812 700 771 324 1168 922 1181 680	700 834 871 923 131	1244 1246 340 1085	1143 792 1147 1148 1144 264 266 1204 615 32 680 117 1084 1246 166 167 1087 1086 478 602 1085	347 594 1122 293 272		1151 416 755 352 1266 1150 483
Picea glauca	946 229 67 68 1071 600 874 873 86 1225 1151 375 1152 608 343 46 1023 978 344	874 361 864	29 1208 386 1224 873 1225 1080 1152 1052 343 1139 1359 516 68 299 344	12 600 1224 873	386 375 746 864 747 214 215 253 939 71 600 1224 1150 621 1139 1128	890 892 891 978 1086 1359 593				1071 86 1080 978 344	690 446 344			1181 1277 516 37	68 1247 1271 1123 1208 759 1274 1273 1152 901 1246 871 1154 923 502	1271 1247 1244 1245 1273 1152 1246 1154	792 459 1144 1143 1146	489 347 1271 560 1204 920 310 615 1205 1273 901 1281 1086 1085 32 1274 31 1275 1277 1278 1279 917 1084 1246 879 1281	1193 1033 875 1150 876 1151 1152 608 361 299 502

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Picea glauca (con't)																		1087		
																		478		
																		880		
Picea mariana	946		68	421	12	746	338			731	1080	690	927	1181	68	1244	1144	1269		1176
	67			68	873	747	978			1286	978	446		971	759		1143	310		607
	382			731		253	1359							974				32		1316
	68			10		408	1130											31		
	719			1176		105												30		
	564			564		939												1275		
	873			311		421												1047		
	402			873		71												974		
	46			784		720												1280		
	978			1080		99												1087		
	1316			720		311												85		
				1044		607												972		
				402		1128												1085		
				1052														880		
				49																
				607																
				47																
				48																
				1359																
Picea rubens	859			859		1111						446		859	788		1147	1269		
	382													783			1148	1087		
	1343													1181			1144	1085		
																	1143			
Pinus spp.	498			524	273	253	1090	1073	1090	1073	429	150	601	498	108	1245	792	922		429
	497			497		849	849	849				849	388	497		708	1145	729		108
	182			301										922				192		
	849			975										631				688		
	610			617										1090						
	617			815										1091						
														975						
														1181						
														701						
														849						
														1092						
														138						
														617						
														815						
														94						
Pinus banksiana	946	835	623	946	1072	744	775	65	1100	699	599	690		775	1008	1010	915	489		599
	1118		375	1118	12	864	1300			1215	2	446		843	767	1244	916	346		1193
	2		361	860	873	747	1302			731	230			280	1123	448	674	952		1009
	229		377	230		408	1216				422			1181	915	1043	459	233		1124
	230			1124		71	280				1071			701	916	916	74	1122		1033
	509			1301			835				1079			812	385	674	1144	387		1215
	1332			297			864				1080			1283	217	675	676	293		1216
	67			699			385							516		625	1143	842		1176
	68			731			1359							810		207		1204		608
	1124			1176			396									626		1203		361
	608			10												443		32		1316
	46			873												708		537		217
	377			1079														1280		
	396			1080														920		
	422			47														310		

Species	Subject																				
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Pinus banksiana (con't)	719			48														915		
	767			516														916		
	1071			1359														1206		
	623			377														1205		
	297			1065														900		
	305																	615		
	873																	288		
	1079																	674		
	1200																	675		
	375																	84		
	865																	917		
	1065																	880		
	1316																			
Pinus echinata	789	23	1187	1188	481	656	1006	597		1006	244	789		578	595	606	517	595		275
	244	22	960	244	580	270	6			724	870	446		1006	580	270	792	1194		796
	653		578	653	1306	1165	666							810	1194		1147	254		739
	578		124	960	174	939	656							1354	254		1012	517		738
	6			21		733	1302							188	451		1148	1353		110
	656			254		1129	870							189	517		1013	1356		
	254			1259		1352	1165							1181	1353		1015	158		
	1259			1048										802	1354		596	1007		
	1048			451										816	533		1016	1354		
	1227			1356										803	534		73	612		
	597			1354										804	597			804		
	127			127										817	521			818		
	124			1165										818				811		
				110										805				805		
				124										812				806		
														820				899		
														1016				533		
														806				160		
														679				334		
														73				932		
														807				515		
														110				933		
														809				1046		
																		816		
																		207		
																		112		
																		803		
																		817		
																		996		
																		681		
																		940		
																		73		
																		688		
Pinus pungens														1181						
Pinus resinosa	1330		836	860	1072	452	756	1073		8 1215	4	690	1051	498	452	416	792	879	416	
	498		1290	29	12	416	1001	662			1071	252	175	322	1008	1010	915	399	1193	
	4		1291	4	836	71	665	663			1136	50	712	324	1141	708	1148	1087	1009	
	295		1292	295	873	853	1301	740			762	1207	715	323	587	1244	1143	1246	1338	
	382		375	1124	1243	836	673				1080	1136	714	1001	1051	1066	1144	940	1124	
	1124		1293	665	1080	744	360				1120	659	25	672	175	448	916	572	1301	
	417		837	417		1293	712				714	801	390	843	1129	1043	674	489	796	
	1071		525	1301		657	661				882	446		1091	834	916	74	346	1033	
	836		381	1129		747	403				978	714		1181	1123	674	676	952	1215	
	1207		376	1267		377	1266				376	1125		680	330	643	1149	322	50	

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Pinus resinosa (con't)	185		377	836			313					378	376	1296	916	625		271	362	
	1290			1207			657					380	1133	807		353		233	836	
	403			51			978						380	1297		626		347	352	
	978			185			593							39		397		594	1266	
	378			376			1132							34		1246		1338	608	
	376			873			1133							831		398		387	572	
	380			1293										1277		399		293	45	
	762			657										1295		376		1198	1127	
	873			307										1149		1085		916	882	
	1291			389										1294				615	11	
	1083			1080										450				616	381	
	1200			450										395				674	38	
	1292			116										812				32		
	375			49										1292				30		
	1293			716										887				932		
	307			381										640				933		
	1294			362										1298				207		
	608			377										593				204		
	45			1297										973				973		
	1120			378										38				1068		
	714													36				478		
	381													35				879		
	1297													810				917		
	377																	685		
																		1005		
																		1170		
																		1169		
																		272		
																		587		
																		1269		
																		266		
																		1204		
																		560		
																		920		
																		846		
																		158		
																		1007		
																		915		
																		582		
																		1024		
																		31		
																		1081		
																		680		
																		1277		
																		537		
																		8		
																		307		
Pinus rigida	1285	440		860		789	1220		1100	723	789	789		322	383	207	792	322		796
	440			789		939	1217			78		446		323			1012	323		383
	724			727		1129	1329			80				789			1013	594		739
	789			21		41								325			1015	1122		572
	1329			441		550								1181				266		738
	441													1220				325		
														1049				158		
														812				204		
														810				572		
																		940		
																		785		

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	iv
Pinus serotina				727	580	1129								1181	580	1108	1012	1007		
				78										810			1013	940		
				79													1015			
				80																
Pinus strobus	406		1119	766	90	452	850	907	1090	1215	1119	903	925	859	452	416	792	489	435	416
	946		641	406	1072	416	665	1073	1093	1286	967	710	390	783	68	1172	428	346	160	1193
	349		68	349	765	758	775	737		627	1071	690	1287	771	1141	1010	1347	322	30	1009
	859		375	859	1131	71	776	736		724	150	150		499	1172	1210	1147	1339	680	1338
	1119		543	460	12	1129	1090	1202			444	444		498	66	1244	1012	1251	933	1033
	498		740	1119	624	919	403	740			151	151		324	1131	1043	1148	231	327	796
	641			3	1202	9	870				445	445		322	1123	249	1013	90	117	776
	497			850		197	1213				152	152		323	560	248	1015	347	681	1210
	760			710		853	978				148	659		850	1078	625		233	685	1215
	851			497		477					762	148		496	403	207		271	56	918
	382			760		744					870	149		497	871	626		594	478	352
	68			90		747					149	446		851	896	896		1122	160	875
	417			851							978			1168	1287	1108		1338	32	608
	1071			68										775	923	1154		1140	932	56
	1109			665										776	614	340		519	515	1257
	918			417										843	131	708		272	633	877
	583			1099										1090	1126			264	204	
	185			1131										476				1269	243	
	403			477										153				205	940	
	930			583										154				206	364	
	1343			185										1091				265	896	
	762			1078										369				266	644	
	117			249										1181				1123		
	999			248										680				560		
	375			117										363				634		
	608			737										737				920		
	543			736										736				717		
	978			450										809				1007		
	896			366										257				992		
	724			821										94				1077		
														812				582		
														450				615		
														367						
														368						
														810						
														831						
														822						
														821						
														366						
														261						
														393						
Pinus sylvestris	649	179	462	90	90	386	1300	462	1090	731	755	446	1051	700	1051	1010	792	90		416
	700	180	700	619	999	53	712	700		627	1249		712	498	266	1244	1347	594		1334
	498		1289	317	53	308	1090	1289		724	619		390	324	871	1245	1147	1122		902
	509		999	1334	558	379	395				978			1168		1043	1148	293		179
	619		179	731	799	416	978							922		625	1144	922		608
	728		375	386		700	799							728		207	1143	272		572
	317		543	401		939	177							843		626		1204		287
	1334			627		386								144		1246		1203		
	902			999										1090		1085		615		
	401			117										1189		708		1206		
	999			370										1181		868		1205		
	117			378										395				1024		
	179			177										812				1233		
	608													810				514		

Species	Subject																				
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Pinus sylvestris (con't)	375																	162		
	370																	117		
	1023																	572		
	308																	1246		
	543																	1085		
	978																	785		
	377																			
	724																			
Pinus taeda	724	1228	1187	1360	481	656	664	1260	965	78	245	845	976	1017	595	606	517	322	803	416
	1360	430	960	244	906	82	665	430		80	894	1053	567	242	938	1250	488	595		796
	244	193	578	960	580	146	1341	477		163	798	446		239	906	530	487	1194		1094
	653	722	82	336	482	1227	673	431		724	1348	1054		110	580	581	1227	264		1348
	578	1134	968	42	430	431	656	432		75	1227			821	1194	1262	1018	254		1095
	245	102	1227	665	172	433	861	433			1350			807	254		1011	517		463
	336	1344	119	938	194	722	668	505			87			1327	517		1012	325		118
	660	5	669	21	174	1165	82	504			870			751	451		1013	754		1350
	656	194	121	82	199	416	671	965			5			813	168		1015	1356		1229
	938		122	1259	624	1129	172	508						812	290		1014	158		119
	7		124	254	1230	1095	870							322	1227		1016	1227		1201
	1259		284	1048	193	1352	24							323	1354		702	732		1157
	254		926	451	1306	770	892							578	255			1007		739
	1048			78	1229	968	890							1341	533			1354		432
	146			290	1231		929							672	213			160		1158
	463			157			891							668	534			533		506
	80			500			669							1260	521			534		1262
	1258			163			284							325	749			996		1263
	1227			750			163							476	116			682		110
	118			751			943							1227	751			683		102
	929			262			1261							1354	292			536		1230
	120			821			1165							975	506			681		505
	193			170			1262							188				805		157
	855			823			1263							1181				685		126
	669			477			234							189				684		504
	722			1227										119				940		283
	127			118										977				648		500
	123			1354										810				56		764
	617			975										257				539		56
	124			255										809				686		943
	157			87										822				530		702
	723			391										1159				687		738
	926			977										75				16		1261
	949			855										833				538		844
	885			121										94				535		507
				127										240				847		508
				392										241				932		203
				749										808				1179		1017
				617										130				933		
				124										814				514		
				116										702				1046		
				567										943				162		
				764										1016				848		
				813										802				820		
				687										816				207		
				1165										964				749		
				110										962				1180		
				75														821		
																		822		
																		811		
																		803		
																		17		

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Pinus taeda (con't)																		1088 55 899 18 688		
Pinus virginiana	629			629 21 476 567 816	481 174			477			894		567 415	629 775 631 470 475 476 1181 1222 1049 812 807 821 257 822 809 810	595 383 415		792 1147 1012 1148 1013 1015	595 1007 612 932 514 933 681 685 940		775
Platanus spp.														1181	839					
Platanus occidentalis			418	128 568	481 778 482 565 568 566 569 315 558 553 174 552 104	795 568 418 128	568 569 870				870			94 809				1125 681 685		795 418
Populus spp.	869 1196 1028 501	1196 1028		1300 93								14	150	282 14	94	839 1123 871 501	448	792	1269 310		
Populus alba	405	405		755 405 841											1181	871					
Populus balsamifera	946 176 869 465 1070 298		176	946	12	176 298 948 1040								1181							
Populus deltoides	1305 1332 1236 1028 358 64	1028 1299 358	462	1305 128 15 1236 568 173	1332 455 1333 482 565 566	1305 795 1028 568 165 1299	568 799	462				15			748 1221 1223	1235 871	863	797	32 863	1235	171 795 1341 419

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Populus deltoides (con't)	501			1341	568	427														
					358	1040														
					173															
					174															
					104															
					427															
					961															
Populus deltoides var. *occidentalis*						128														
Populus grandidentata	335			356		357	226				77	690		1223						
	1070			77		335	72					304		807						
	356			1049		76	661					446		810						
	1349					355						793								
	77					356														
	793					303														
						304														
						1349														
						563														
						77														
						1049														
						793														
Populus nigra var. *italica*	1061		1062			1063								1181	871					
						1062														
Populus tremuloides	62	1163	176	296	12	1039	226	1163		724	762	710		1181	614			1045		348
	176	1041		109		1038		1041			77	690		680				680		
	382	1042		356		1035		1042			1164	304		1049				1357		
	1070			77		1042						446		1223				1002		
	296			1049		523						793		807						
	1027			424		1163								810						
	109			425		793														
	191			1164		424														
	356					1034														
	449					357														
	598					425														
	762					61														
	1343					62														
	77					1045														
	424					645														
	794					1069														
	793					176														
	609					296														
	724					1027														
						1040														
						1036														
						103														
						522														
						1041														
						1164														
						794														
						76														
						191														
						348														
						356														
						355														
						303														
						449														

Species	Subject																				
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Populus tremuloides (con't)						304														
						563														
						190														
						77														
						1049														
						948														
Prunus spp.	547			898									601			448	792	1269		
Prunus pensylvanica	382																			
Prunus virginiana	229				1332															
	1332																			
Prunus serotina	382	181		872	482		226				762	710		809						
	762			72	174		72					446								
	181				104		713													
Quercus spp.	547		375	652	104	838	852	462			245	690	282	779	839	448	792	652		966
	652		462	182	481	711	1329					691	1323	324	966			222		329
	1178			999	482	795	145					692		631	1141			690		1268
	653			711	174							329		1181	1210			691		795
	245			566	566							150		807	573			1269		1209
	182											1197		94	1209			1210		
	375											969		810	871			208		
	184											446		145				1345		
	999																	329		
	711																	527		
	1285																	1197		
	1329																	689		
	1212																	27		
																		493		
																		207		
																		28		
																		169		
Quercus alba	394	780	652	481		733	851	1241		787	245	98		779	652		792	272		1241
	652		1178	906			226	1242				1135		780	906			98		1242
	1178		244	156			72	787				693		220	573			169		
	244		336	1060			1329					1195		1181	871			208		
	245		414	104								613		239				693		
	336		220	707								446		240				1173		
	1056		156	103										241				613		
	660		1135											810				113		
	414		706															1175		
	220		707															454		
	156																	1067		
	1135																	1240		
	854																			
	184																			
	1285																			
	183																			
	706																			
	1329																			
	787																			
Quercus bicolor	220		220	455										220				169		
				104																

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Quercus coccinea	1178			1178	156		1329					159						272		
	156			156								586						169		
	1285											446						159		
	183																	493		
	1329																			
Quercus ellipsoidalis	305						611					98						98		329
												693						169		
												329						693		
												659						329		
												446								
Quercus falcata					481							159		1181				169		
					174									145				159		
Quercus falcata var. *pagodaefolia*					565													169		
					566													1104		
					174															
Quercus lyrata	656				481	656	656													
					906															
					482															
					174															
Quercus macrocarpa	544			544	1332	128	661				15	1253		748	403			272		
	1253			128	455						13	690		1253				690		
	1332			509	12							691		326				691		
	509			274	104							98		1181				98		
	274			15								693						169		
	13											659						693		
	211											446						881		
	305																			
	403																			
	854																			
Quercus marilandica	244			244	481	733			1325			1195						272		
	336			336	156	711						613						169		
	156			156	174							446						613		
	711			711								753								
Quercus muehlenbergii	781				174													169		
Quercus nigra					481							446						169		
					482													208		
					174													1175		
Quercus palustis	202			220	164	568	568							220			792	272		202
	220			568	455		569							810			1337	169		
					1333															
					482															
					565															
					568															
					566															
					569															
					315															
					104															
Quercus prinus	1318			1135	481	1319	851	909				1135		1181	906		1147	272		1319
	1319				906		906					446					1148	169		

Species	Subject																				
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Quercus prinus (con't)	437 1135				909																
Quercus rubra	781 652 1178 544 244 382 336 417 1056 15 13 979 156 220 211 1135 762 117 854 908 608 543 706		462 705 543	133 652 1178 544 128 244 336 417 455 156 220 1135 117 908 705 709 707 706	15 906 156 12 1177 1060 707 104 799	133 128 1248 705 219 359 886	664 756 226 72 906 799	462 359 1241 1242			133 13 762	1182 1135 693 1346 1336 159 446		779 220 1181 1049 810	906 1235 871 614			652 272 169 693 1346 159 113 454 1067 1240	1235	796 1182 1336 526 608 1214 219
Quercus stellata	1178 244 336 156			1178 244 336 156	481 156 1060 174	733	1328	345		345		446 753						169			
Quercus velutina	244 336 854			244 336	1060 104	733		1241 913				691 1195 159 613 446		1181 1049 810	1209 1235 913			272 691 169 159 613 493 1240	1235	526 1241
Rhododendron spp.	726																792 1347	996			
Rhododendron maximum	1284																	259			
Rhus spp.																448					
Rhus copallina	335			335		335						446 753									
Rhus glabra												753									
Robinia pseudoacacia	509 195 465 13 660 543		766 543	133 1155 195 72 766 1317 841	481 174	133 416 227 704 1155 1138	72 703	1323 1100		133 195 13 703	446	282 925 227 588 589 1323	227 588 589 1232 1181 279 831	857 521 871	606	1147 1148	272		416 171 1215 1232 1317

Species	Subject																			
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Salix spp.	1139																			
	501			411	411	1139	1300		52	1115				1181	839	448	792	207		
	723			250	250	246	163			163										
	1178			731	558	218				724										
	1236			93	52	1236														
				1139	481	948														
				1115	455															
				163	174															
				1236																
Salix alba	509		462		558	427		462							871		797	996		
	897				427															
Salix nigra	724			95	481	1162	568			1115										795
				568	455	1333				724										
				1115	1333	795														
					482	568														
					568															
					566															
					174															
					104															
Sassafrass albidum	547				481	335			415			446	415							
	335				482	733														
	415				174															
					104															
Taxodium distichum	825			825	312	416	1300			673				94	825			1007		416
	312			312	1178	694	314								906			996		314
	1178			198	198	198														
	198			309	481	1226														
	673				906															
	309				673															
					694															
					1226															
					314															
					174															
Thuja spp.						253						150			923	708				
Thuja occidentalis	859	469	68	859		746						710		859	68		792	884		416
	68		70	860		747						658		884	276		1144	1269		201
	70		375	939		416						659			884			1206		
	382			68		939						446			1123			1024		
	69			70		69									871			192		
	71			884		71									319			32		
	276			469		884												30		
	884			878														1089		
	437																			
	469																			
	375																			
	878																			
Tilia spp.					481					1335		150		1181	1335					
					1335															
Tilia americana	781		462	544	12	58	851	462			15	710		779		448		1269		59
	544		780	1332	58	745	226					446		780						608
	1332		59	15	1177	59	72							1181						
	382			72	174	74	57							905						
	211			872																

Species	Subject																				
	IA,B	IC	ID	IE–1	IE–1a	IE–2	IIA	IIB–1	IIB–2	IIC	IIIA–1	IIIA–2	IIIA–3	IIIB–1	IIIB–2a	IIIB–2bi	IIIB–2bii	IIIB–2biii	IIIB–2biv	IV
Tilia americana (con't)	58 608			57																	
Tsuga spp.												150		1181	839						
Tsuga canadensis	407 1178 68 382 1343 930 375 724		68 375	407 1178 68 72		747 1156 71	72 1131			724		903 893 658 659 285 446		407 1181	757 1057 68 1123 871 923 1082 131	708	792 1347	452 594 1269 266		1082
Ulmus spp.	223											150	282	324 1181	839	448	792				
Ulmus alata	781 238 1332 509 201 225 224 382 202 1200 1050				481 778 482 174																
Ulmus americana			462	509 201 90 224 665 15 72 872 568	1332 164 481 455 778 482 306 12 568 566 1335 174 104	745 747 416 755 568	226 1001 665 72 568	462	1335	238 15	710 528 529 883 446 753 227	415	1001 1222	1235 1209 1141 1210 993 1335 415	797	1024 1205 528 32 883 277 995	1235	416 224 202		
Ulmus rubra				72			72														
Ulmus thomasii	608				12																608

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